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IFES 2017: What Is Up with Soybean Yields?

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This is a presentation summary from the 2017 Illinois Farm Economics Summit (IFES) which occurred December 18-22, 2017. A complete collection of presentations including PowerPoint Slides (PPT) and printable summaries (PDF) are available here.

Soybean yields in the U.S. have been very high the last four years. The U.S. average yield set new records in a stair-step fashion each year between 2014 and 2016. The 2016 yield reached the remarkable level of 52.1 bushels. While not a record, the 2017 yield (based on the November 1 USDA estimate) was 49.5 bushels, the second largest ever. On top of the high U.S. average yields are the numerous reports of field-level yields in the 70s, 80s, and even a few in the 90s.

The high soybean yields of recent years have sparked a debate about what is driving the exceptional yields. In thinking about this debate it is important to understand that there are only three possible sources of soybean yield gain. The first is weather during the growing season. The second is genetic improvement in soybean varieties. The third is a management, which encompasses all aspects of the soybean production process. Genetic improvement and management sometimes go hand-in-hand so that one requires the other.

It is a not an easy task to disentangle the complex and sometimes interacting impacts of weather, genetics, and management on soybean yields. One approach is to use a crop weather regression model to estimate the separate impacts of weather and technology on soybean yield, where technology is the combined impact of genetic improvement and management. I estimated this type of model for U.S. average soybean yields over 1970-2017. A linear time trend was used to represent technological change and summer precipitation and temperature variables were used to represent growing season weather. The modeling results showed that U.S. average soybean yields in 2014, 2015, and 2017 could be explained by a continuation of the linear improvement in technology and good growing season weather. The exception was 2016, when yield was substantially higher than what could be predicted based on a linear technology trend and good weather. It is not clear from this exercise whether we should view the 2016 yield like a 100-year flood or a permanent jump in soybean yield potential.

Agronomic data can be helpful in further disentangling genetic improvement from other sources of soybean yield gain. One recent study collected seed for over 150 soybean varieties released from the 1920s through the 2000s. Using randomized trials from across the country in 2010 and 2011, the study estimated "pure" genetic improvement in soybean yields. The results indicated a linear progression of soybean genetic yield gain from 1970 through 2008. This indicates that the historical pattern of soybean genetic gains in yield have been steady and marked jumps in the rate of improvement are rare. Soybean

variety test results from the Department of Crop Sciences at the University of Illinois provide relevant data through 2017. The yield of conventional soybean varieties relative to the older Williams variety shows no change of trend in recent years. Overall, there is little evidence to date that soybean genetics have been improving at a faster rate in recent years.

If we dig into the soybean yield data for the U.S. state-by-state an interesting pattern emerges that points to important changes in management practices. In general, soybean trend yields in the Southeastern U.S. have been growing at a much faster rate than in other growing regions. This non-linear trend appears to be related to a number of management practices, which can be roughly described as having the purpose of replicating Midwestern growing conditions. This includes planting much earlier in the past, planting earlier maturing indeterminate varieties, including corn in the crop rotation to increase organic matter in the soil, and using raised bed production systems. These management practices have allowed soybean yields in the Southeast to largely catch up with those in the rest of the country.

In sum, the data indicate that the biggest factor explaining high soybean yields in recent years is simply exceptionally good growing season weather. Improved management practices, particular in the Southeastern U.S., have also certainly contributed. A jump in the rate of genetic improvement in soybeans was not likely a big contributor to the surge in soybean yields.

Additional Resources

The slides for this presentation can be found at:

http://www.farmdoc.illinois.edu/presentations/IFES_2017

For related analysis, see the following *farmdoc daily* articles:

Irwin, S., T. Hubbs, and D. Good. "What's Driving the Non-Linear Trend in U.S. Average Soybean Yields?" *farmdoc daily* (7):86, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 10, 2017.

Irwin, S., T. Hubbs, and D. Good. "U.S. Soybean Yield Trends for Irrigated and Non-Irrigated Production." *farmdoc daily* (7):81, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 3, 2017.